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ABSTRACT

The purpose of this study was to augment current knowledge regarding the antecedents of statistics anxiety and negative attitudes toward statistics among graduate students. The researchers also sought to investigate and identify promising methods for gathering and analyzing data in order to advance study in this emerging domain. Initially, 3 focus groups were planned for the 69 graduate students in 3 sections of an introductory statistics class, but many students were not able to participate in focus groups, and instead answered a questionnaire about statistics anxiety. Findings from the two focus groups and the student questionnaires were combined with student responses to two existing measures of statistics anxiety. Qualitative data affirmed the validity of much of the extant knowledge about statistics anxiety, but also disclosed new facets of knowledge, such as the importance of time management skills, and the identification of some previously undelineated factors. Among these is the fact that the availability of a dependable source with whom to compare answers reduces students' anxiety and frustration. Embedded in these data are important hints for instructional design. The comparison of focus group and open-ended survey data suggests that focus groups provide a substantially richer substrate for the generation of fertile text. Written responses provided no themes that were not revealed in focus group transcripts. One appendix contains suggestions for conducting focus groups, and the other contains a reading list about mathematics and statistics anxiety. (Contains 7 figures, 7 tables, and 15 references.) (SLD)

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Multifaceted Foci: The Antecedents of Statistics Anxiety and Negative Attitudes Toward Statistics

Perspective

Most major publishing houses carry at least one title addressing statistics anxiety (SA) or a work designed to present the concepts of statistics absent formulas. Sage has Neil J. Salkind's *Statistics for People Who Think They Hate Statistics* and a third edition of Richard Jaeger's *Statistics: A Spectator Sport*. Prentice Hall has a third edition of Gerald Kranzler's *Statistics for the Terrified*—and the list goes on. The number and emotional intensity of the titles, the fact that many are in their second or third edition and several other relatively new volumes on the same subject have been authored in the last few years reflect the seriousness of this problem.

As McLeod (1992, p. 575) observes: "Affective issues play a central role in mathematics learning and instruction. . . . If research on learning and instruction is to maximize its impact on students and teachers, affective issues need to occupy a more central position in the minds of researchers." The reference was to mathematics education, but it applies to statistics education as well. Similarly, Gal, Ginsburg, and Schau (1994, p. 40) state, "The extensive body of research on affective issues in mathematics education can be used to guide a discussion of affective responses to statistics education."

According to McLeod (1992, p. 575) ". . . if students are going to be active learners of mathematics who willingly attack nonroutine problems, their affective responses to mathematics are going to be much more intense than if they are merely expected to achieve satisfactory levels of performance in low-level computational skills." The same dynamic operates, and likely explains in part, the high rate of statistics anxiety among graduate students. Onwuegbuzie and Wilson (in press) report that some researchers estimate the percentage of graduate students who are uncomfortably anxious about statistics to be as high as between 66% and 80%.

> Statistics anxiety has been found to be extremely prevalent among women and minorities, and some researchers believe statistics anxiety may, in part, prevent some graduate students . . . from completing their degree programs. Most of the recent increase in research activity concerning statistics anxiety has been directed towards undergraduate students. More investigations are needed, especially with respect to graduate students and interventions. (Onwuegbuzie & Wilson, in press)

Other researchers (Perney & Ravid, 1991) share the view that students often delay taking required statistics courses as long as possible. Graduate students in statistics are dealing with a form

of math that is highly non-routine and they know they have to pass the course to obtain their doctorates, even if, sadly, some plan to pay others to "do the stats" in their dissertations.

Gal and Ginsburg (1994) observe that much of the research on attitudes toward statistics (which, in their conceptualization, includes statistics anxiety) has used Likert-type response scales that, although convenient for generating broad descriptions and for reporting, produce little diagnostic information about individual students, information that is critical to guide intervention and inform changes in pedagogy. One component of the arsenal of assessments Gal and Ginsburg (1994) recommend is the use of structured interviews or focus groups. Krueger and Casey (2000, p. 9) assert that focus groups work because "...people self-disclose...and say what they really think and feel... when they feel comfortable and when the environment is permissive and nonjudgmental." That's more likely to happen, needless to say, away from the classroom.

The complexity of a phenomenon and its resistance to easy analysis are often related to the proportion of emotional content. Few things are more emotional than fear (anxiety *sans* the euphemistic cloaking) and few more resistant to change than emotionally charged attitudes. One of the definitions Webster's New Collegiate Dictionary (1974) gives for foci is "a center of activity, attraction, or attention. " Statistics anxiety is a complex problem, and to design effective instructional practices to ameliorate even a small portion of the discomfort so many students feel, we must take our search to new depths, and we must do so with finer, more delicate methods that can detect the qualitative differences with which we're grappling.

Purpose

The purpose of this study was to augment current knowledge regarding the antecedents of statistics anxiety and negative attitudes toward statistics among graduate students. Additionally, we sought to investigate and identify promising methods for gathering and analyzing data in order to advance future study in this emerging domain. We approached this research endeavor by conducting moderated focus groups, and combining the feedback resulting from these focus groups and written responses to similar open-ended questions with respect to statistics anxiety (SA) and negative attitudes toward statistics (NATS).

This investigation complements current data collection efforts employing existing and modified survey instruments developed to measure statistics anxiety (i.e., the *Statistical Anxiety Rating Scale – STARS*—Cruise, Cash & Bolton, 1985) and attitudes toward statistics (i.e., the *Survey of Attitudes Toward Statistics* – SATS). The 51 items in the STARS instrument all use a 5-point response scale, with a high score indicating either a high level of anxiety and/or a negative attitude towards statistics.

The SATS was developed by Schau, Stevens, Dauphinee and Del Vecchio (1995, copyright pending) and consists of 28 items, utilizing a seven point Likert scale. A high score on the SATS reflects a positive attitude toward or view of statistics. Results informed *EncStat* (Encouraging Excellence in Statistics), a statistics anxiety intervention program under development that is designed to identify students with statistics anxiety (SA) or negative attitudes towards statistics. Major elements of *EncStat* include identification of students with SA, amelioration of that anxiety using cognitive behavior therapy techniques, and assisting students to achieve more positive attitudes toward statistics, while providing concept and skill support exercises.

Method and Data Source

Several activities were planned for this thread of our research program. First, moderated focus groups were conducted to obtain detailed information about aspects of statistics anxiety and negative attitudes toward statistics especially concerning, but not limited to, those aspects amenable to intervention with interactive multimedia. Initially, three focus groups were planned for 69 graduate students enrolled in three sections of an introductory statistics course (EDF6407) at a Research I urban university in the southeast. Owing chiefly to time constraints and congruence of the initial data with previous findings from the literature, after the first traditional in-person discussion group (Focus Group One), students electing to participate in the research effort (but who did not participate in the focus group) agreed to answer the same set of questions in written form. This supplementary approach was intended to obtain data amenable to the planned content/thematic analysis. In order to gain additional insight, after these initial data were collected, we elected to conduct another moderated focus group (Focus Group Two) with students enrolled in a different section of EDF 6407.

Finally, vignettes of two prototypical statistics anxious students and one non-anxious student were constructed. In a related study, these students completed the *STARS* and *SATS* as well as weekly Statistics Anxiety Affect Checks. Scores on the *STARS* and *SATS* were used to identify prototypical students. The Statistics Anxiety Affect Checklist is a pilot instrument consisting of 21 emotion words (which cohere around seven basic emotions, five of which were identified by Eckman, 1992), each of which is rated on a 7-point scale (ranging from 1 = "Do Not Feel This Way at All" to 7 = "Feel This Way Intensely"). Focus group or written response comments, affect check results and commentary were used to explicate these students' beliefs, feelings, and experience of statistics. Table 1 presents the data sources and analyses conducted and reported in this study.

Table 1
Data Sources and Analyses

Data Source	Analysis Conducted: Frequencies	Content Analysis	Thematic Analysis
Written questions	X	X	
Focus Group One transcript	X	X	X
Focus Group Two transcript			X
Vignettes:			
STARS/SATS scores			
Statistics anxiety weekly affect checks			

Data Analysis

Boyatzis (1998) categorizes code development as theory-driven, prior-research-driven, and data-driven. Regarding prior-research-driven code development, Boyatzis (p. 37) observes that literature review often guides code development. "Codes used by other researchers and their findings provide the most direct help in developing a code from prior data or prior research." This approach facilitates the use of what Strauss and Corbin (1990) call "axial coding" or regrouping of categories used in previous research.

Although no code was found for analyzing focus groups on statistics anxiety, the conceptual model for statistics anxiety intervention, developed in a related research effort (Watson et al., 2003) was used in the development of a code that was employed in our preliminary analysis of the qualitative data gleaned from the focus groups and written responses. Fawcett (1986) defines a conceptual model as "a set of abstract and general concepts and propositions that provides a distinctive frame of reference for the phenomena of interest to a discipline."

The materials assembled for analysis included transcripts from Focus Group One (consisting of six students from one section of EDF 6407); responses to a set of 10 open-ended items which were similar in nature and content to questions asked in the focus groups; and transcripts from Focus Group Two (consisting of six students from another section of EDF 6407). Materials for constructing vignettes for three prototypical students included scores on the *STARS* and *SATS* and results of Statistics Anxiety Weekly Affect Checks.

Our research team was divided into two groups, one focused on the written questions and another tasked to analyze the transcripts. Given the length of the focus group transcripts and the

nature of the data collection, it was decided that the group would analyze initially the transcript of Focus Group One and the written questions that were collected from students enrolled in the same section of EDF 6407. As no written responses were available for the group of students who participated in Focus Group Two, the transcript from that group was used to supplement information gleaned from Focus Group One and the subsample's auxiliary written responses.

In the process of coding the transcript and written responses, inconsistencies became evident between the code that was initially developed and the data to be analyzed. Much of the incongruity arose from the presence of issues or problems not previously noted in the literature or investigated in the conduct of inquiry regarding statistical anxiety. Such incongruities might be indicators of previously unexplored or undiscovered antecedents to statistics anxiety and/or major landmarks in the relatively unexplored domain of statistics anxiety intervention (for example, content specific factors, such as the plethora of new concepts and the hierarchical nature of statistics). Review of results suggested that although discrepancies arose in some cases due to lack of clarity or excessive category breadth or narrowness, in many instances new categories had to be created to accommodate the reflections of the respondents.

Boyatzis comments (1998, p. 35) that "theory-driven codes. . . [and by extrapolation, prior-research-driven codes] are developed 'out of context' of the type of material to be coded. Therefore, the specifics of the operational code (i.e., the detailed code to be used on the source material) may be inappropriate to the material to be coded." This possibility was considered particularly critical in this instance, with "Theory-driven codes . . . [being] . . . relatively more sensitive to projection on the part of the researcher and to the impact of his or her cultural bias." (Boyatzis, p. 35). Because the beliefs and assumptions of previous researchers (most of whom were also statistics instructors) upon whose work the concept model was based, would potentially obscure and bias the interpretation of these data, the protocol was revised using a modified data-driven approach, where the categories are derived from the data. The amended code was utilized to recode both the focus group transcript and the set of written responses.

The Focus Group Two transcript was subjected to thematic analysis, and similarities and differences between themes in the thematic analysis and themes revealed in the content analysis of the focus group and the written responses were noted. Finally, *STARS* and *SATS* scores for students participating in the focus groups were reviewed. Of those scoring above the median in SA and NAS, two were selected as prototypical SA students, while one scoring below the first quartile was selected as a prototypical nonSA student. Affect check results for these three students were considered in light of their measured levels of statistics anxiety.

Results

Written Questions. As mentioned earlier, this study was part of a larger exploration of antecedents to statistics anxiety. We developed a set of 11 open-ended questions (Table 2) to complement data collected via the *STARS* and *SATS* scales, with the goal of piloting these questions to investigate their utility in collecting the sort of qualitative data found in focus group work, but more efficiently. (Because it addressed an area (statistics software used) that would be idiosyncratic to each institution, Question 6 was not included in the content analysis.) The questions were as open-ended as possible for this initial effort. After piloting and revision in the current study, in later research efforts these questions will be triangulated with *STARS* and *SATS* subscale scores.

Table 2
Focus Group and Written Response Questions

1. What do you think causes stats anxiety?
2. Please think back over the last semester and describe what it is about statistics that makes you most anxious.
3. What could your instructor do to make you less anxious?
4. Are you comfortable asking your instructor or classmates or someone in the stats lab for help?
5. Are you comfortable and confident working on your own? Can you explain why or why not?
6. How do you feel about the statistical software used in the course? (not included for analysis in this study)
7. Please describe what is good about the course you've taken
8. Please describe what needs improvement
9. What could your instructor do to increase your learning?
10. If you could give some advice to statistics instructors, what would you say?
11. Is there anything else you'd like to add? How can we make the next focus group better?

Included in this set of inquiries were questions directly addressing statistics anxiety (e.g., *What causes stats anxiety? What it is about statistics that makes you most anxious?* and *What could an instructor do to make you less anxious?*). Questions also probed students' comfort level with respect to asking for help (from both the instructor(s) or classmates) and their confidence and comfort in working individually. Respondents were also asked to provide feedback about the positive aspects of their statistics course as well as to identify areas in which potential improvements might be made. Additionally, students were asked what their instructor could do to increase their learning and what advice they might give to other statistics instructors. A final question allowed respondents to provide additional comments they deemed appropriate.

Weber (1990, p. 57) explains that the category count approach to analyzing text "counts words that have been classified into categories...counting assumes that higher relative counts (proportions, percentages, or ranks) reflect higher concern with the category." As Boyatzis notes (p. xiii) "..Converting themes into codes and then counting presence, frequency, or intensity does not in and of itself create a link between qualitative and quantitative methods. The computation or articulation of interrater reliability, or convergence of perception of multiple judges, must occur as well." Convergence of perception of multiple judges--four in the written response analysis and three in the transcript analysis--was deemed an appropriate method for this exploratory effort.

The highest frequencies of response for each question are presented in Table 3 and commented upon in the following narrative, which also lists the lower frequencies not appearing in Table 3. Frequencies across questions were not tabulated because each question tapped a different construct.

Table 3

Frequencies of Response for Written Questions

Code	Freq	Category
Item #1 What do you think causes statistics anxiety?		
C2	3	Vocabulary/Language
C4	4	Formulas
C8	3	Too much material
F16	6	Math skill deficit prior achievement
Item #2 Please think back over the past semester and describe what it is about statistics that makes you most anxious?		
C2	3	Vocabulary/Language
C3	3	Concepts
C7	3	Hierarchical
C11	2	Data analysis/interpretation
F25	2	Time Stress
F45	3	Test Anxiety
Item #3 What could your instructor do to make you less anxious?		
C3	2	Concepts
I13	2	Recognition of anxiety
I18	3	Use of activities to aid understanding
I25	5	Other

Item #4 Are you comfortable asking your instructor or classmates or someone in the stats lab for help?

F10	3	Study skills & habits
I22	4	Discussion with peers
I25	3	Other
SS4G	7	Guidance – opportunity for practice, doing homework, etc. w/qualified guidance

Item #5 Are you comfortable, and confident, working on your own? Can you explain why or why not?

F16	2	Math skill deficits /prior achieve/. No. & type math classes taken/math anxiety
I22	9	Discussion with peers
I25	2	Other
SS3	3	Get alone
SS4G	6	Guidance – opportunity for practice, doing homework, etc. w/qualified guidance

Item #7 Please describe what is good about the course you've taken

C3	5	Concepts
I18	2	Use of activities to aid understanding
I22	2	Discussion with peers
I25	8	Other
SS4G	3	Guidance – opportunity for practice, doing homework, etc. w/qualified guidance

Item #8 Please describe what needs improvement.

C9	4	Other
I25	2	Other
O1	2	Achievement
SS4G	2	Guidance – opportunity for practice, doing homework, etc. w/qualified guidance

Item # 9 What could your instructor do to increase your learning?

I25	7	Other

Item # 10 If you could give some advice to stats instructors, what would you say?

I25	9	Other

Item # 11 Anything else?

I25	4	Other
O2	2	Understanding & use of research

With respect to the first question, *What do you think causes statistics anxiety?*, the most frequent reasons given were characteristics of the learners rather than characteristics of the content and materials. Math skill deficit and prior achievement in math were the most frequently mentioned causes ($n = 6$), with personal histories about the number and type of math classes taken ($n = 1$), perceived intellectual ability ($n = 1$) and existing stereotypes and myths ($n = 3$) identified less frequently. Characteristics of statistics content were less frequently identified as causes of anxiety, with formulas ($n = 4$), vocabulary and language ($n = 3$), and quantity of material ($n = 3$) the most frequently cited problems. Only two respondents commented on the level of difficulty of the subject, and single respondents identified the abstractness of the discipline, the hierarchical nature of the material and the abstractness of the subject matter.

When asked to *Think back over the past semester and describe what it is about statistics that makes you most anxious*? (Question 2), students' responses were similar in nature to the ones described above, but characteristics of the content were most frequently mentioned. Responses were equally balanced among difficulty with the concepts, vocabulary and language and the hierarchical nature of the subject ($n = 3$, for each). Similarly, two participants identified issues surrounding the formulas, numbers and calculations and data analysis and interpretation, while a single participant noted too much material. The most frequently identified characteristics of the learner were test anxiety ($n = 3$) and time stress ($n = 2$). Finally, an individual student noted a lack of adequate study skills and habits, while another perceived a deficit in math skills.

In response to Question 3, *What could your instructor do to make you less anxious?*, students' reflections fell within three major categories: content-specific factors, dispositional factors, and instructors' behaviors. With respect to content-specific factors, the most frequently mentioned issue was the course concepts ($n = 2$). Individual students also commented on the vocabulary and language, the use of numbers and calculations, and the necessity to analyze and interpret data. Dispositional factors appeared to cohere around two sub-domains. The first sub-domain appeared to reflect a rather global self-perspective. Individual respondents reported perceived scholastic competence, intellectual ability, satisfaction with the statistics course, and past history with respect to math. The second sub-domain appeared to be more situation specific. For this sub-domain, students' comments were related to test anxiety, math anxiety and math skill deficits, with each of the aforementioned comments mentioned only a single time. The third major category represented in these data was related to instructor behavior. Students commented on the instructor's use of activities to aid understanding ($n = 3$), recognition of anxiety, pace of the course, and the patience of the instructor (with $n = 2$, respectively). Additional comments from individual students suggested that their statistics instructor was encouraging and available to the students. Further, students commented on the instructor's use of

humor, the use of incremental scaffolding steps to teach difficult material, and the provision of opportunities to be successful.

When student's were asked, *Are you comfortable asking your instructor or classmates or someone in the statistics lab for help? (Question 4),* the majority responded in a positive manner. However, because of the double-barreled nature of the question, it was often difficult to discern if the students were comfortable asking their instructor for help, asking their classmates for help, or both. For example, one response was "yes, absolutely." In this instance and several others, we could not reasonably assign that response to either the instructor or their classmates. When other comments were offered, the most frequent reasons provided were related to the opportunity for practice, homework, etc. with qualified guidance ($n = 7$), discussions with peers ($n = 4$), and study skills and habits ($n = 3$). Additional responses that appeared only once were exam taking strategies, encouragement, and instructor availability.

Students' had divergent feelings about working alone or with others as evidenced by their answers to the questions addressing this issue: *Are you comfortable, and confident, working on your own? Can you explain why or why not?* Of the 19 respondents, only five cited strong negative feelings about working alone. Of the remaining 14, exactly half indicated that they not only liked but actually preferred working alone. The other seven indicated some level of confidence and general positive attitudes toward working alone while also indicating that they enjoyed some degree of interactions, such as "cross-checking" their answers with others, "bouncing ideas off of others", etc. Content factors were cited minimally ($n = 2$) in response to this question, noting formulas and concepts as issues of concern. Situational and dispositional factors showed up occasionally ($n = 3$) in the guise of concerns about their math abilities and general scholastic competence. The overwhelming areas that respondents' answers aligned with were interventions ($n = 11$) and study strategies ($n = 9$). Within the realm of interactions, students mentioned peer interaction nine times. When addressing study strategies, three students felt that getting alone with the material was important while six individuals tended to indicate a need for guidance, including guided practice, homework, etc.

Reactions to the question *Please describe what is good about the course you've taken* addressed a plethora of issues. The majority of comments ($n = 14$) focused on intervention techniques, including the recognition and acknowledgement of anxiety, the use of activities to aid understanding and peer-based discussions and interactions. Over half of the respondents ($n = 10$) specifically identified the instructor as a key positive element in the course. Comments ranged from the general (e.g., "The instructor explains well" and "Dr. XXX is excellent at explaining") to more specific examples (e.g., "The professor provides wonderful real life examples" and "his approach was more conceptual and related and connected to how we would use the stats"). Additionally, students mentioned the

availability of resources such as notes prior to class as another helpful aspect of the course. In addition to intervention techniques a small number of students (n = 4) cited situational and dispositional factors such as computer use as a positive aspect of the course while six mentioned conceptual issues and three intimated study strategies promoted by the class such as guided practice were also helpful.

The responses to the item *Please describe what needs improvement* tended to focus on support aspects of the course such as books, facilities and computer programs. Six of the respondents did not respond to this item and of the thirteen that did, their input was quite diverse. Seven of the comments involved conceptual matters, including the tendency to cover a lot of material in the course. Two individuals addressed concerns about the weighting of grades in the course, suggesting that the percentage of points toward their final grade that came from tests was, in itself, anxiety inducing. Dispositional and situational factors were found in seven responses, including concerns with class length, perceived lack of utility of a required textbook, group work (e.g., reliance on others' contributions), and inadequate facilities. Another area that responses addressed was study strategies with students suggesting more practice opportunities/homework, a for-credit prerequisite course, and guided study session with a teaching assistant. Overall, students' cited neither content (with one exception) nor instruction as areas in need of improvement. Rather, their concerns tended to come from indirect, albeit important, aspects of the course design and delivery.

Response frequencies for questions 9, 10, and 11 confirmed the need for coding protocol refinement. All showed frequencies of one for several categories, with the majority of responses falling into the *Instructor Behaviors – Other* category.

Seven of the 16 responses (44%) to Question 9, *What could your instructor do to increase your learning?* were coded as *Instructor Behaviors – Other*. Of those seven responses, two suggested that professors be patient with students and two thought a greater emphasis on application would be helpful. The remainder of the seven *Instructor Behaviors – Other* responses, appeared to confirm the notion that causes of SA are varied. Four of the remaining six responses to Question 9 involved content-related factors. Six students specifically gave positive comments about the instructor and said nothing more could be done The following responses occurred only once: vocabulary/language; concepts; formulas; too much material; satisfaction with statistics course; understanding and use of research, and the need for guided practice.

Question 10 showed a similar pattern of response frequency, with nine of 15 responses in the *Other* category. Of those nine, four mentioned patience, one specifically suggesting patience regarding rusty math skills. One request for more real-life examples was made, and two students suggested instructors be mindful of the fact that not everyone had the "... interest and talent in the field..." the instructors did. Six students made positive comments like, "Keep up the good work: and "You're doing

well" Responses occurring once were: concepts, math skill deficits and math anxiety; encouragement; breaking material into small steps; achievement; and understanding and use of research.

Responses to Question 11, *Is there anything else you'd like to add?*, showed more variation overall: only four of the 14 were coded as *Instructor Behaviors – Other*. Patience on the part of the instructor and the use of an applied approach, as well as an "appropriate pace" were specifically credited with reducing anxiety. The following responses occurred once: content factor (related to the statistics software used in the course); perceived scholastic competence; math skill deficits and math anxiety; course status (elective or required); reduction in anxiety level caused by appropriate pace and a focus on application; encouragement; recognition of anxiety; understanding and use of research; and anxiety.

Focus Group Transcript. With most of the existing research based on results of scales using Likert-type responses (as noted by Gal and Ginsburg, 1994) it was believed that focus groups, which produce a nuanced understanding, were an appropriate method with which to examine this complex phenomenon.

Content analysis of a focus group transcript differs in fundamental ways from the analysis of responses to written questions, even if essentially the same questions are used and even if, as was the case with both focus groups, conditions and discussions are nearly ideal. Reasons for the disparities included the effect dominant talkers have (subjects important to them are mentioned more and at greater length), the inability to ascertain when one comment applies to other participants who keep silent, the possibility of the group devoting more time to answering the first questions, a myriad of interpersonal dynamics not present in individual written responses, and the greater time for peaceful, solitary reflection involved in writing a response as opposed to verbally responding (a potentially highly influential difference for some personality types, particularly those tending to be anxious).

After overview of the transcript, the team agreed that the most appropriate unit of analysis for coding the transcript of Focus Group One was that of comments by one speaker on one subject, rather than a sentence or paragraph. Sentences and paragraphs often addressed multiple subjects. The transcript was marked accordingly and coded using the amended code developed during analysis of the written responses.

Convergence of perception of multiple raters (in this case, three) revealed the frequencies presented in Table 4

Table 4
Frequencies of Response for Transcript of Focus Group One

Code	Freq	Category
Dispositional Factors		
F2	22	Perceived scholastic competence
F3	6	Perceived intellectual ability
F8	4	Statistics preknowledge
F12	5	Learning disabilities
Situational & Environmental		
F16	4	Math skill deficits
F19	4	Programming experience
F25	15	Time stress (in personal life)
F27	10	Group work in class
F31	5	Past math history (negative personal experience)
F32	6	Other
F37	7	Size of class
F44	8	Other
Content		
C2	12	Vocabulary/language
C3	10	Concepts
C4	6	Formulas
C6	8	Newness
C8	16	Too much content/too little time
C9	26	Other
Outcomes		
O2	5	Understanding and use of research
Psychological Reactions		
PR1	8	Panic, paralysis
PR2	7	Anxiety
PR3	11	Frustration
PR5	13	Other
Physiological Reactions		
Phy1	4	Tears
Study Strategies		
SS1	5	Notetaking and rewriting
SS4	33	Other
SS4G	26	Opportunity to check work with qualified person
Instructor Behavior/Techniques		
I11	5	Positive attitude
I16	5	Availability
I22	10	Discussion with peers
I25	44	Other

Four aspects of these focus group data are particularly noteworthy, given their frequency of occurrence and their importance in the area of SA. Students in Focus Group One expressed doubt about their scholastic competence ($n = 24$), identified the lack of time to devote to the study of statistics they thought was necessary ($n = 15$), noted too much content was covered in too little time ($n = 16$), and talked of the need for guided study opportunities ($n = 30$). These critical issues suggest that effective intervention should include efforts to build student confidence in their scholastic abilities, time management training, and formal opportunities for guided study. Assuming that the course content is not readily amenable to reduction, the improvement in time management skills and the provision of guided study opportunities may reduce the perception of excessive content.

The other categories captured a noticeably large portion of the frequencies. Although possibly an artifact of the unit of analysis and idiosyncracies peculiar to focus groups as noted previously, these results provided guidance in reconfiguring the code as follows. The Dispositional-Other category seemed to function well as did the Situational and Environmental-Other category, the latter having two mentions of classroom activities and three about tracking. (Incidentally, all three comments were made by separate individuals each of whom had not and/or would not mind having students exceptionally bright in statistics in class with them and did not want to be in a group of "slow learners". One student specifically said that had been demoralizing for them in the past.)

With the addition of one category –Statistics Software--the Content category seemed appropriate; all 26 of the Content-Other mentions concerned software. Of the 9 responses falling in the Psychological Reactions-Other category, two referenced feeling childish, and two seemed to reflect an unusual desire to please. A new category, Study Skills-Guided Study, would account for 25 of the 33 responses coded in Study Skills-Other.

In the Instructor Behaviors-Other category, eight of those mentions could be grouped with Individual Help and Breaking Material into Small Steps to form a category of Instructional Techniques. The specific items listed included more real world application, showing all steps, taking the time necessary to explain, and being organized, with class notes available to students before class. Another category, Instructor Characteristics, would include the two mentions of being gentle, six of being accepting, four of patience, two of being supportive, and two of courteousness. After relocation of those items, 24 mentions remained in the instructor Behaviors-Other category, indicating that future efforts should delineate this category further.

Comparison of written response frequencies and focus group frequencies. The transcript of Focus Group One showed only a single mention of being an older student, which was one of the most dominant and often-referenced subjects in Focus Group Two. This variation across groups supports the need for following established guidelines suggested by Krueger (2000) of conducting more than

one, and typically three, focus groups. Also noteworthy is that the written responses revealed a higher frequency of math or math-related constructs (e.g., concepts, vocabulary, symbols) as causes of SA, than the focus group. The data from both focus groups and those from the written responses consistently showed that students saw a need for "someone to check my answers with." Clearly, this should be a prime target of intervention.

The most dramatic difference between written response frequencies and focus group frequencies is that several topics focus group discussion revealed as highly important to students (panic and inability to concentrate in the classroom, the need to be alone and in a quiet setting to concentrate, the lack of time in one's personal life, and feeling dumb) were not mentioned in written responses (see Table 5). The most obvious reason (that no question tapped that subject) gives a partial explanation. The failure of written responses to capture this critical information (and had more focus groups been done, more areas would no doubt have been identified) indicates that written responses alone do not give a full picture of statistics anxiety antecedents, particularly those aspects heavily influenced by institutional, regional, classroom, and demographic differences.

Another noteworthy difference between data from focus groups and from written response questions is the effect of group synergy. With focus groups, when conditions are good, participants ask each other clarifying questions that can be quite direct and revelatory of fundamental issues—with no offense meant or taken. And the person being asked to clarify does so, often at great length. Having shared the same experience facilitates participant understanding and enables participants to dig for information in a way impossible with written responses and that would require considerable time using structured interviews. Even if the rest of the group just listens and gives only confirmatory head-nods, having one's peers agree with and confirm one's experience leads to more and fuller disclosure. Finally, the process itself is, as one participant expressed it, "therapeutic." And thought, as well as words, flow freely when the tension of discomfort is released. As one student said, "I had no idea so many others felt the same way! I'm glad I'm not the only one!"

Thematic Analysis of Focus Group Two Transcript. As mentioned earlier, thematic analysis of both focus groups was done before coding to minimize bias inherent in using a protocol based on previous research. This initial thematic analysis of the in-person focus groups yielded results confirming findings in the literature, such as that students had no idea many of their classmates also had distressingly high levels of anxiety and discomfort, were very nervous during class and could not think clearly, or were afraid to ask questions for fear of looking foolish.

Table 5 delineates the themes that emerged during data analysis and indicates whether a theme was present in one or both focus groups and the frequency with which it was identified in the written responses. Those themes marked with ** were not delineated in the written responses.

Table 5
Themes identified in Focus Groups and Written Responses

	Themes	Focus Group One	Focus Group Two	Written Responses
**	Panic in classroom	X		
**	Have to work alone at home to concentrate	X		
	Too intimidated to ask questions in class	X	X	X
	Past history of trouble with math, including teachers	X	X	X
	Math anxiety	X	X	X
	There's a math type of mind		X	
	Concepts			
	Concepts – abstractness	X		X
	Memorizing concepts does not work		X	
	Little instruction in concepts as opposed to rote learning in school (older student comment)		X	
	Terminology	X	X	X
	Hierarchical nature of material	X	x	X
	Symbols	X	X	X
	Formulas		X	X
	Course Structure			
	Need slower pace to allow for incubation time X two	X	X	X
	Amount of content should be reduced	X		X
	More time for content covered in latter part of semester		X	
	Grade level requirement of B caused anxiety		X	
	Requirements too generic		X	
	Backgrounds of class members too diverse		X	
	Smaller class size	X	X	
**	Questionable value of group projects	X		
	Need for narrative or case studies and practical applications	X		X
	Stress from final and midterm weighing so heavily in grades	X		X
	Personal Factors			
	Being older student and a long time since math classes		X	
**	Questioning worth of stats I		X	
	High personal standards - not satisfied with just getting by		X	
**	Feeling dumb	X	X	
	Lack of time in personal life	X	X	
	Large amount of time required to do work each week	X	X	
	Test anxiety	X		X
	Learning disorder	X		
	Interpretation anxiety	X		X
**	Desire to use statistics after done but questioning ability to do so	X		
	Need for persistence		X	

Study with Others			
No one qualified to help with homework and projects (other students not sure either)	X	X	X
Need for study group and help in forming one		X	X
Hard to meet with classmates due to personal time stress		X	X
Self-doubt and lack of confidence	X	X	X
Materials			
Text hard to use and understand	X	X	X
Statistics software hard and too time-consuming to learn	X		X
Learning program at same time as learning statistics content difficult		X	

Note. Although not coded, the following instructor characteristics and habits were mentioned as being helpful for students who experience anxiety: Gentleness, patience, courtesy, friendliness, acceptance, a caring attitude, avoidance of humiliation, being supportive, observant, accessible, aware, not demeaning of students, generous with time, responsive and demonstrating an underlying trust.

Vignettes of Prototypical SA and non-SA Students. Vignettes of two prototypical statistics anxious students and one non-anxious student were constructed for this initial study. The selection criterion for the SA students was a score greater than the median (2.27) on the *STARS* (an instrument designed to measure SA) and for the non SA student, a score below the 25th percentile (1.67). Scores on the *SATS* (which includes statistics anxiety within its affect subscale) provide other information essential to understanding the role attitude plays in SA and NAS. A high ATS score on the SATS indicates a positive attitude toward statistics. Table 6 presents SATS and STARS scores, midterm and final grades, and subscale scores. Table 7 presents these students' responses to demographic and questions relating to math and statistics background on the SATS Finally, Figures 1 through 7 graphically depict the degree of intensity these students felt each week with respect to the seven emotions, as indicated on affect checks they voluntarily completed. Selected written comments made by these students supplement the narration following.

Table 6.
STARS, SATS, Achievement, and Subscale Scores.

	Survey Scores		Grades		SATS SUBSCALES*					STARS*SUBSCALES				
ID	SATS	STARS	MID	FIN	Affect	Cog Comp	Value	Diff	Worth	Interp	Tst Clss	Com pute	Fea Hlp	Fear Tch
22	3.86	3.16	73	67	1.5	3.5	6.3	3	2.38	4.09	4.5	3.7	3	1.2
23	3.07	2.96	83	77	2.17	3.17	4.3	2.14	3.44	2.27	3.13	3.71	2.67	2.2
11	5.32	1.66	100	87	6.17	6	5.3	4	1.18	2	2.38	1.29	2.33	1.4

* SATS (a 7-point Likert scale): mean = 4.17, SD 1.07, median 4.11;

* * STARS (a 5-point Likert scale): mean 2.34, SD 0.77, median 2.27

Table 7
Responses to Demographic and Related Questions on the SATS

	Student ID No.			
Question	**22**	**23**	**11**	**Response Scale (1 to 7)**
How well did you do in your high school mathematics courses?	5	5	6	Very Poorly to Very Well
How good at mathematics are you?	5	5	6	Very Poor to Very Good
Hw much computer experience have you had?	6	7	6	None to A Great Deal
How much experience with statistics have you had (e.g., courses, research studies)?	3	3	4	None to a Great Deal
In the field in which you hope to be employed when you finish school, how much will you use statistics?	5	5	5	None to a Great Deal
How confident are you that you have mastered Introductory statistics material	1	3	6	Not at all Confident to Very
In general, how do you compare females' and males' skills in statistics.	4	6	4	Females Much Better to Males Much Better
Sex: 1. Male 2. Female	1	2	1	
Ethnicity	1	1	1	1=White American
Degree currently seeking	4	4	4	4=Doctorate
Expected grade	2	2	1	1=A, 2=B
Age	39	46	27	
Hours earned toward current degree	6	3	36	
Current grade point average	4	4	3.7	
Years high school mathematics taken	4	4	4	
Number college mathematics and/or statistics courses taken	7	3	3	

We have only begun trying to think about these data and what they may be able to tell us.

Initial visual check of the graphs yielded the following impressions:

- Students sitting in the same class, listening to the same instructor experience a broad range of emotions and emotional intensity.
- In general, the most extreme levels of the negative emotions are being experienced by the most anxious student.
- All three students indicated the generally expected absolute and relative positions on each of the emotion scales, i.e. following the pattern of their STARS and SATS total scores.

- Achievement, as measured by midterm and final exam scores, was also as expected, with the student indicating the lowest anxiety attaining the highest score.
- Graphs for Anger, Fear, Sad, Confused, and Dumb generally vary together over the course of the semester. The literature speaks of the SA student as feeling anxious and not too bright, but none or rare mention is made of anger and sadness, emotions which also have a significant impact on learning, concentration, and motivation.
- There is a great deal of variation, week to week, for each student.
- The student with the most intense feelings (Student 22) also seemed to have the most variability week to week.
- What is perhaps the most telling of all is how intensely students felt angry, afraid, and dumb. Sadly, this affirms what most teachers of statistics had suspected for years and which the work thus far with Likert scale type surveys has demonstrated: that some students experience high levels of negative emotions.

Figures 1 through 7 present a week by week charting of each student's self-reported level of the seven emotions measured in the Statistics Anxiety Affect Check (anger, fear, indifference, sadness, enjoyment, confusion, and feeling "dumb".)

Figure 1.

Anger

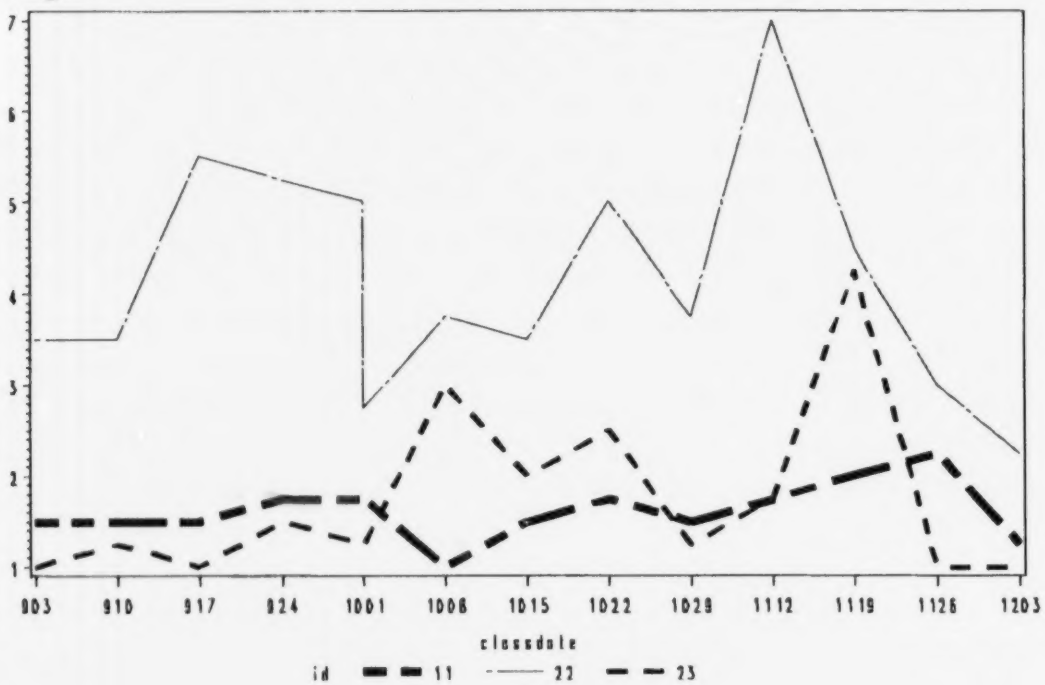


Figure 2.
Fear

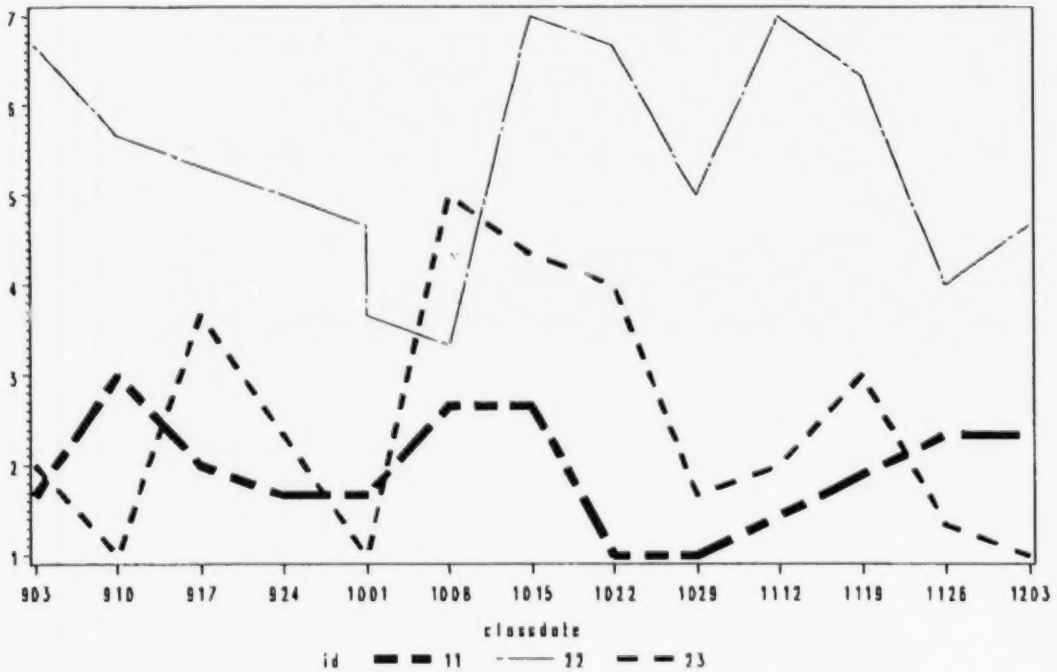


Figure 3.
Indiff

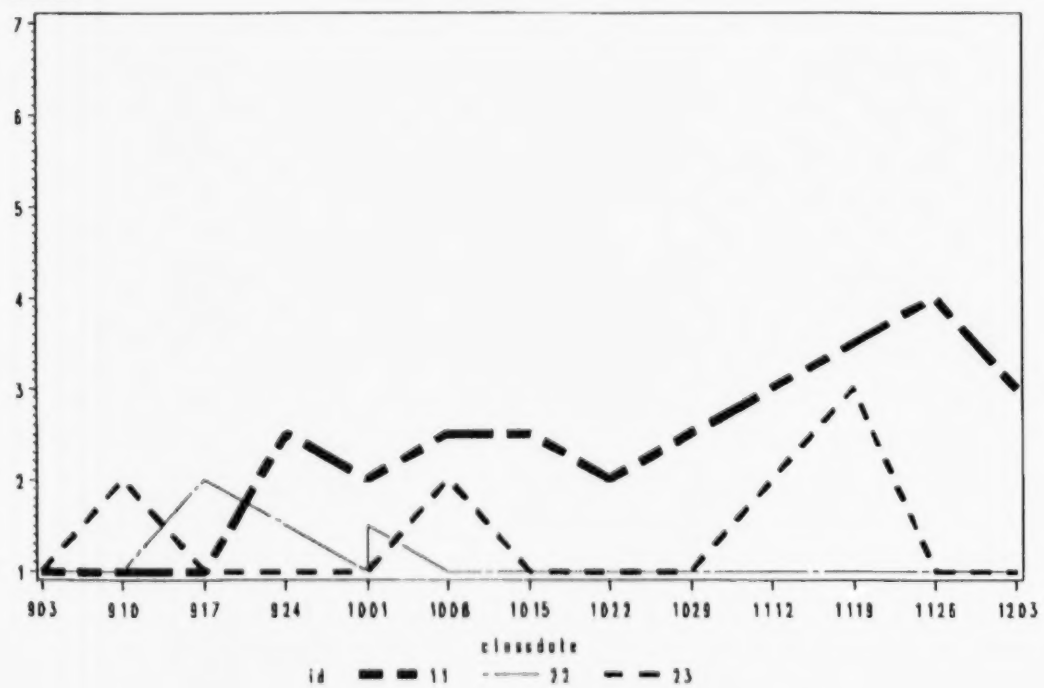


Figure 4.
Sad

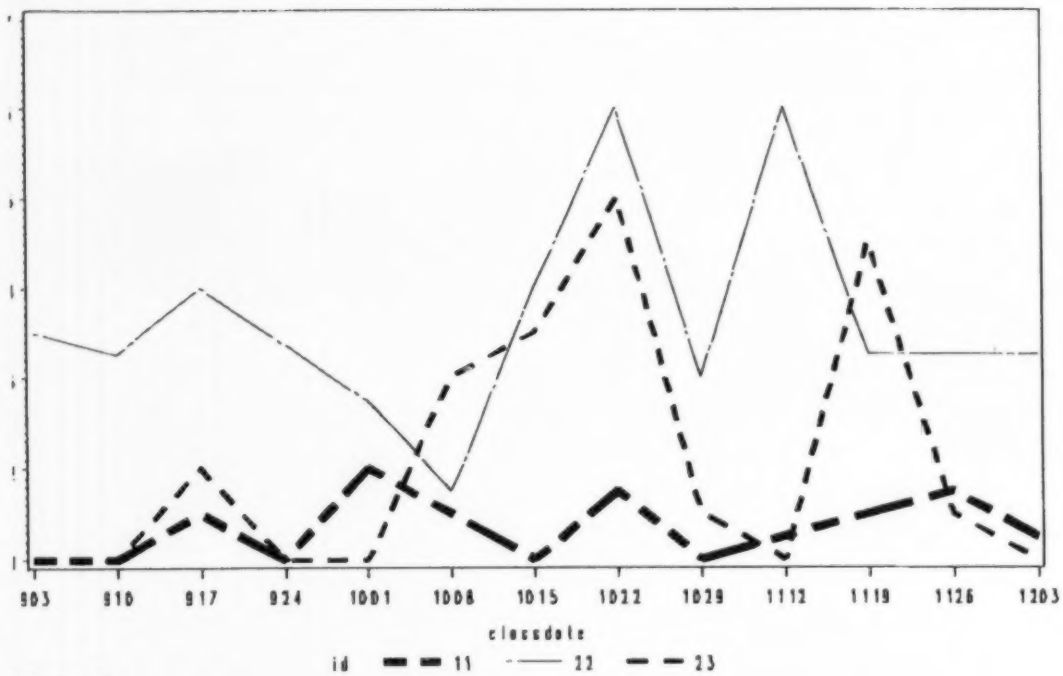


Figure 5.
Enjoy

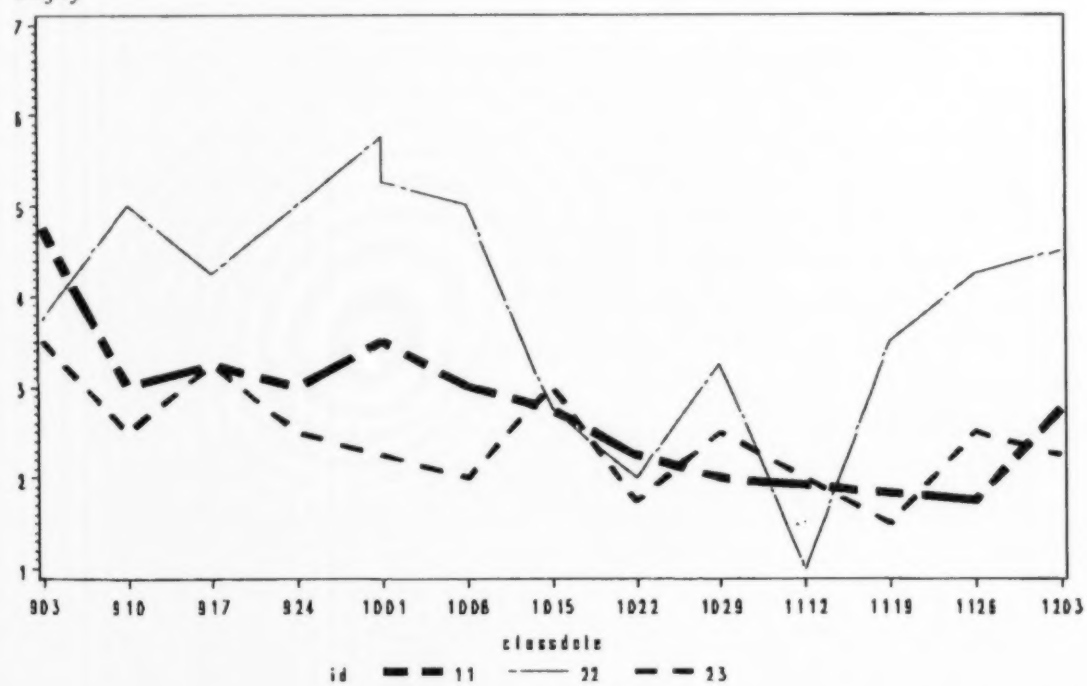


Figure 6.
Confuse

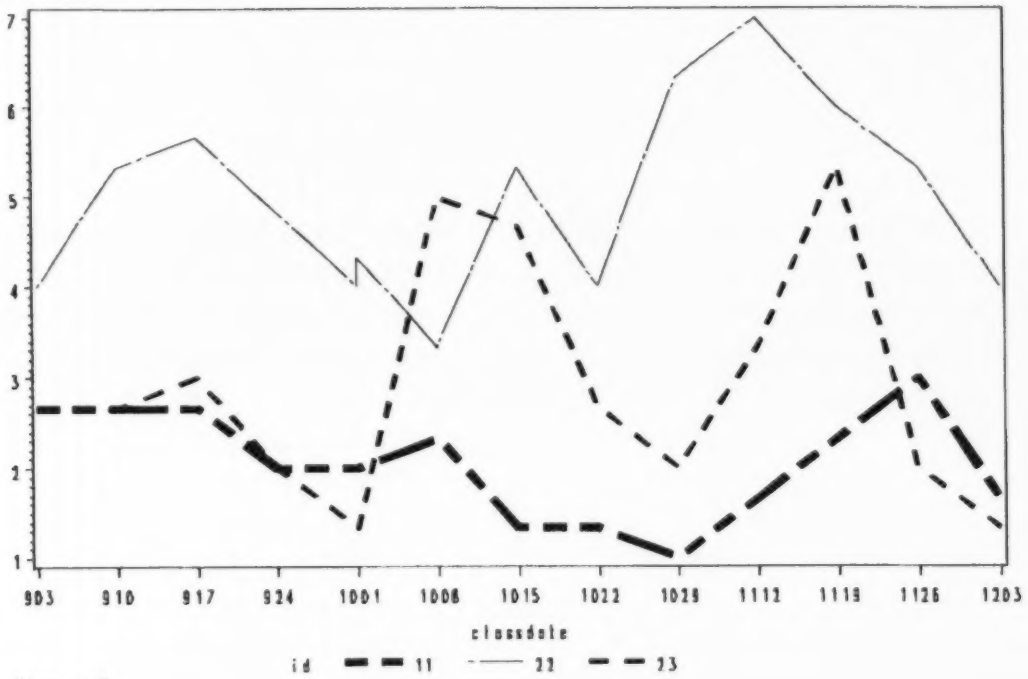
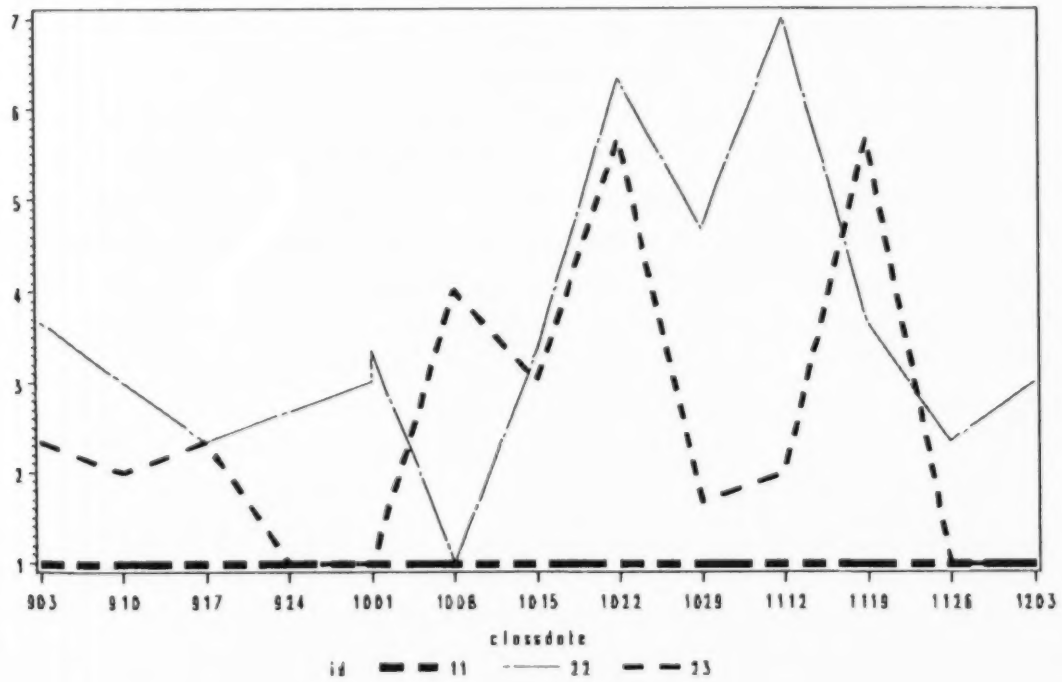


Figure 7.
Dumb



As part of the weekly affect checks, students supplied explanatory commentary. The comments from Student 11 (the "little to no anxiety" student) were as expected: "When I am faced with a new concept, sometimes I am a little confused. However, I am always confident I will figure it out, and usually do." The student completed 12 affect checks but seemed to have little to say, other than short quips like, "Exam is coming!" "Did okay on the midterm." Student 23's comments were a little more revealing: "The content is intense with a great deal of information to absorb." and "Material is more and more complex."

Again, the student measured as having the highest statistics anxiety, as indicated by the STARS, gives evidence for a number of characteristics of the SA student that research has been confirming. With the first class of the semester, Student 22 writes, "I am an English Teacher. Math makes me crazy." Later it's "Class went on and on and the information kept piling up until I felt overflow." After the midterm (10/22) the student explains, "I feel this way because I had the lowest grade in the whole class.. It seems almost impossible to get a passing grade now. However, I am already canceling all plans for the rest of the semester so I can focus on this class. My anxiety level is through the roof as I watch myself struggle to keep my head above water." Two weeks later: "I just found out I gave the professor the wrong stuff for my first homework. It is next to impossible to pass now. *There is a very good chance that I will drop out of the program after the class. Stats is a good way to weed out those who can't grasp math [emphasis added].*

Discussion

We began this investigation wanting to find out more about the causes of SA (where *cause* is defined from the learners' points of view). Our qualitative data affirmed the validity of much of the extant knowledge (e.g., that the perception of statistics as heavily mathematical results in a significant amount of anxiety and that specific teaching behaviors reduce anxiety) but also disclosed new facets of that knowledge (e.g., the importance of personal time management skills) and what seems to be the identification of some hitherto undelineated factors at work in the process of statistics anxiety (e.g., that the availability of a dependable source — someone whose knowledge of statistics they can trust— with whom to compare "answers" would reduce students' anxiety and frustration, facilitating their learning). Embedded in these data lie important hints at effective intervention design.

Methodologically, our comparison of focus group data collection with open-ended survey data, suggests that the former provides a substantially richer substrate for the generation of fertile text. As shown in Table 5, the written responses provided no new elements that were not revealed in the focus group transcripts. Despite the relative paucity of data provided by the written responses, this method of data collection provides a vehicle through which a broader sample of students may contribute. That is,

giving voice to those who are not able (or were not selected) to attend a focus group session is an important social contribution of the written surveys.

The fact that the written responses addressed all but six of the themes covered in focus groups would seem to lend support to the idea that three focus groups produces theoretical saturation referenced by Krueger (2000) . However, it seems more likely that with complex phenomena such as SA, and especially in the early stages of knowledge development, conducting at least three focus groups is prudent. Another major theme might have been identified if a focus group of the written respondents had been conducted. The transcript of Focus Group Two shows that those students considered their older student status a key factor in their anxiety, a topic that was not discussed by Focus Group one, though participants were similar in age.

This work, of course, represents an initial venture into the use of focus groups and open-ended written questionnaires to investigate SA. Further work is necessary to advance research in this area and to provide a broader base from which to build intervention strategies. A serendipitous byproduct of this study was the creation of guidelines and materials for efficient qualitative research involving focus groups and short open-ended surveys (Appendix A), including a piloted list of questions (Appendix B) and a code to content analyze the resulting data (Appendix C). These materials may provide background for additional work at other sites.

In the investigation of emerging phenomena, one never knows what to anticipate. Glimpses of an infrastructure accumulate and a tentative sketching of new boundaries suggests that a reconfiguration of the knowledge accepted by the research community may result in a more verisimilitudinous charting. As with a surface-level view of an iceberg, the majority of the object of study has been only roughly approximated and its most distinguishing features remain undetected. To design effective teaching strategies, one must ascertain precisely what it is one's students know and do not know; the same applies to the design and investigation of intervention strategies. Information based on responses to Likert scale items thus far has provided the knowledge necessary for a basic understanding of statistics anxiety and negative attitudes towards statistics. This study presents a methodology to confirm the integrity of that infrastructure, and build upon it. Further work will provide the level of detail sufficient to guide intervention as well as improve teaching practice.

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Appendix A

Suggested guidelines for conducting focus groups on statistics anxiety

1. If you've never conducted a focus group before, read *Focus groups, a practical guide for applied research. 3rd edition* (Krueger, R. A. & Casey, M. A.)
2. Use the list of questions in Appendix B or modify them. If you intend to administer surveys about statistics anxiety, give the surveys before conducting the focus groups. Focus groups can bias subsequent survey responses because focus groups educate participants about the phenomenon under investigation.
3. Be sure your informed consent contains a brief definition of statistics anxiety. Not everyone will automatically assume it must be similar to math anxiety.
4. Convene at least two, and preferably three, focus groups. This will enable you to attain what Krueger calls "saturation," (Krueger, 2000.p. 26) the condition where collecting more data provides no new information.
5. Ask those students who are not selected to complete the same questions in written form. (Requesting that students respond electronically will speed data analysis.)
6. Conduct focus groups after the midterm and before the final, but not so near the end of term that students are even more than usually time-stressed.
7. Have a reading list of books on statistics anxiety (such as that in Appendix C) to offer to students at the end of the focus group.

Appendix B

Focus Group and Written Response Questions

1. On a scale of 1 to 5, with 1 being little to none and 5 being a great deal, please indicate how anxious you are about statistics.
2. What causes your anxiety? (If you're not anxious, just indicate that.)
3. What do you think causes stats anxiety for most people?
4. Please think back over the last semester and describe what it is about statistics that makes you most anxious.
5. What could your instructor do to make you less anxious?
6. Who of the following are you comfortable asking for help: your instructor, your classmates, or someone in the stats lab ?
7. Are you comfortable and confident working on your own? Can you explain why or why not?
8. How do you feel about the statistics software used in your statistics course?
9. How do you feel about the textbook?
10. Please describe what is good about the course you've taken
11. Please describe what needs improvement
12. What could your instructor do to increase your learning?
13. If you could give some advice to statistics instructors, what would you say?
14. Is there anything else you'd like to add? How can we make the next focus group better?

Appendix C

Statistics and Math Anxiety Reading List

Statistics Anxiety

Jaeger, Richard M. (1993) *Statistics, a spectator sport, (2nd edition.)* Thousand Oaks, California: Sage Publications. Excellent book. Explains statistics concepts, deliberately avoiding math symbols and equations. If you're highly verbal, you'll probably enjoy this book.

Jasingh, Lloyd. (2000) *Statistics for the utterly confused.* New York: McGraw-Hill. Presents basic concepts, and exercises, in elementary statistics, using a "Dummies" approach (their words—not ours!) Contains applications for business, economics, finance, etc.

Kranzler, John H. (2003) *Statistics for the terrified (3rd edition*). Upper Saddle River, NJ: Prentice Hall. One of the best books for the statistics-anxious student. Has basic math review and chapter specifically addressing anxiety, as well as coverage of graduate level statistics topics.

Pyrczak, Fred. (1999) *Statistics with a sense of humor (2nd edition).* Los Angeles: Pyrczak Publishing. A workbook and study skills guide. Excellent practice exercises for statistics (in a fun format) and study tips. The 3rd edition is a larger version, using the same format, because earlier editions were so successful. See www.pyrczak.com

Salkind. Neil.J. *(2000) *Statistics for people who (think they) hate statistics.* Thousand Oaks, CA: Sage Publications, Inc. One of the best books for the stats-anxious student. Slow-paced and entertaining, clearly written, highly humorous, and content similar to that for graduate statistics courses.

Math Anxiety

Arem, C. A. (2003). *Conquering math anxiety: A self-help workbook.* Pacific Grove, CA: Brooks/Cole. A self-help workbook.

Kitchens, Anita Narvarte. (1995) *Defeating math anxiety.* Richard D. Irwin, Chicago. A self-help workbook.

Tobias, S. (1987) *Succeed with math: Every student's guide to conquering math anxiety (1st edition)* . New York: The College Entrance Examination Board. The classic book on math anxiety. Excellent chapters on math anxiety and problem-solving strategies. Rest of book covers math concepts and mathematical thinking.

Appendix D

Code for analysis of qualitative data investigating statistics anxiety.
(Page one of two)

Code	Freq	Category
Dispositional Factors		
F1		Perceived scholastic competence
F2		Perceived intellectual ability
F3		Statistics preknowledge
F4		Learning disabilities
F5		Dispositional factors – Other
Situational & Environmental		
F6		Math skill deficits
F7		Programming experience
F8		Time stress (in personal life)
F9		Group work in class
F10		Past math history (negative personal experience)
F11		Older student status
F12		Size of class
F13		Situational/Environmental – Other
Content		
C1		Vocabulary/language
C2		Concepts
C3		Formulas
C4		Numbers/calculations
C5		Newness
C6		Too much content/too little time
C7		Statistics software
C8		Statistics textbook
C9		Content – Other
Outcomes		
O1		Achievement
O2		Understanding and use of research
O3		Outcomes – Other
Psychological/ Physiological Reactions		
R1		Panic, paralysis
R2		Anxiety
R3		Frustration
R4		Tears
R5		Reactions – Other
Study Strategies		
S1		Notetaking and rewriting
S2		Getting alone
S3		Opportunity to check work with qualified person
S4		Study Strategies - Other

Appendix D

Code for analysis of qualitative data investigating statistics anxiety.
(Page two of two)

Instructor Behavior/Techniques

I1	Positive attitude
I2	Patience
I3	Acceptance
I4	Availability
I5	Instructor Characteristics/Behavior – Other
I6	Breaking material into small steps/showing all steps
I7	Real world applications
I8	Instructional techniques – Other

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